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METHOD OF EXPLORATION FOR BURIED DEPOSITS

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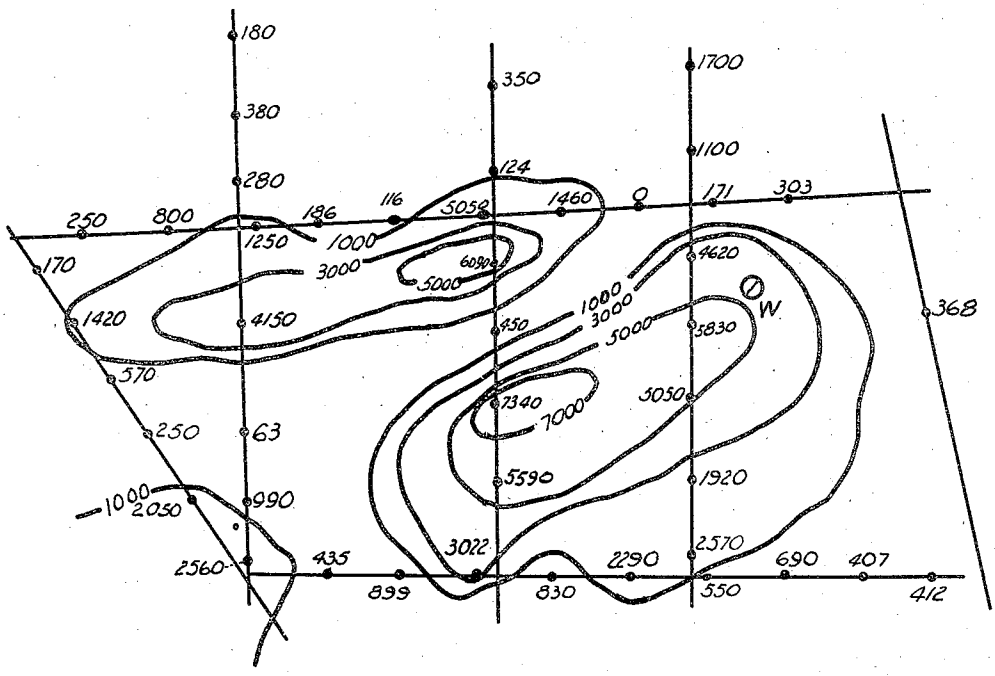

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METHOD OF EXPLORATION FOR BURIED DEPOSITS

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This invention relates to geochemical exploration for hydrocarbon and associated minerals by soil sample analysis. It relates particularly to a method of utilizing my discovery that free hydrogen and carbon monoxide are present in measurable quantities in soil and soil gas samples and that these gases form a part of the leakage products from oil, gas and related deposits.

Experimentation along the lines disclosed in pending application No. 107,497 by E. E. Rosaire and Leo Horvitz has led to the discovery that soil samples heated in the presence of moisture and in a partial vacuum give off hitherto unsuspected constituents, namely hydrogen and carbon monoxide in measurable amounts. By sampling over a considerable area, it has become evident that the amount of these constituents given off correlates with the location of known hydrocarbon deposits. In fact, small amounts of hydrogen and carbon monoxide have been found in air samples taken above ground, and in air samples taken at the bottom of shallow bore holes.

The exact nature of the reactions involved is not yet known but it is believed that chemical changes in the buried deposits or their leakage products cause a complex chemical combination in which hydrogen and carbon monoxide are loosely held in chemical or physical combination such that these constituents can be liberated. It is also evident that some of each of these gases is freed by natural processes, since, as above indicated, free hydrogen and carbon monoxide are found at the surface of the ground or in shallow bore holes. In any event in accordance with the present invention the amounts of hydrogen and carbon monoxide are quantitatively determined and experience shows definite correlation between the hydrogen or carbon monoxide anomaly and the presence of hydrocarbon deposits.

Not only have tests been conducted over known oil and gas fields, but fields have been predicted and subsequent drilling has substantiated the predictions.

One object of the invention is to provide means and method for utilizing this newly discovered principle for the purpose of geochemical exploration.

An object is to discover deposits of buried hydrocarbons by sampling soil, and treating the samples in a manner that freed hydrogen and carbon monoxide may be measured quantitatively to determine anomalous conditions which exist by virtue of the presence of buried deposits.

It is also an object of the invention to discover buried carboniferous deposits by taking samples of air, either from bore holes or near the earth's surface, and analyzing the air for minute traces of free hydrogen and/or carbon monoxide.

Still another object of the invention is the discovery of buried deposits of oil, gas, sulphur, and associated minerals by securing samples of soil or soil gas near the surface of the earth, at a plurality of known points, treating the samples, and measuring the amount of hydrogen and/or carbon monoxide evolved.

The invention will be best understood and other objects together with the foregoing will be apparent from the following description and reference to the single figure of the drawing which shows a contour map of an area in which the contours are drawn for constant amounts of hydrogen measured.

Other investigators have made geochemical analyses in the search for buried deposits of oil or gas. Some of these have been indicated by collecting the gas which is often found seeping from points on the earth's surface. If these seeping gases contain ethane or hydrocarbons other than methane, such a seep is considered to be significant in the search for buried deposits of oil or gas. However, the localization of such seeps is materially facilitated by an overlying layer of water, so that seeps are rarely, if ever found upon dry land. Further such seeps may be only marsh gas.

I have found that soil at the earth's surface which overlies buried hydrocarbon deposits contains molecular hydrogen together with carbon monoxide, as well as the previously known carbon dioxide and hydrocarbons. These gases may be liberated from the soil samples and their amounts may be determined by certain treatment of the soil samples. The preferred treatment consists in heating the soil samples in partial vacua. It is noted, however, that small amounts of gas have been found to be evolved even if the heat treatment is omitted. Analysis of the evolved gases disclosed the presence of hydrogen and carbon monoxide as well as the previously well known emanations of methane, ethane, carbon dioxide, etc. These newly discovered constituents of the leakage products have been found in considerable concentrations, the hydrogen exceeding 1% of the total evolved gases, and the concentration varying with the locality in a manner which is correlatable with the known existence of oil deposits.

As previously mentioned, the exact chemical

nature of the production of free hydrogen is not yet well understood, but results of recent experiments lead to the belief that in freeing the hydrogen from the soil sample, hydrolysis is involved. Treatment of samples with acid or alkali in addition to heat, moisture, and low pressures has resulted in some cases in an increased hydrogen evolution which increases the quantitative sensitivity of the method. Addition of water to dry samples has been found to increase the amount of hydrogen evolved in some cases, which further substantiates the theory that hydrolysis is one of the factors involved. In a routine method of treatment of samples addition of water to dry samples is deemed advisable.

The cause of the presence of carbon monoxide is also not known. It is possible that the presence of this gaseous constituent is the result of partial oxidation of deeply buried deposits, whence the gas migrates in a manner comparable to the migration of hydrocarbon gases as previously known. It is to be understood, however, that this suggested explanation of the presence of these gases is in no way a limitation of the invention, as the invention broadly comprehends a process in which a quantitative determination of these gases reveals anomalies which are correlatable with the presence of buried deposits.

Patches of earth in which hydrogen is found are distributed irregularly over the earth's surface, and to all outward manifestations do not appear to be different from adjacent, but non-hydrogen bearing soil. In the contour map of Fig. 1 are shown the results of an actual survey completed before the discovery well was indicated as being productive. The discovery well is marked W in the figure. Figures on the contour lines indicate the H_2 concentration, being expressed in parts per million of total evolved gas.

Attention is called to the fact that the discovery well is within the most outstanding area of hydrogen concentration. Further, while there are other areas of this hydrogen concentration in the area investigated, the others are poorer in quality, and are more sparsely distributed in a way which is at least roughly related to their approximate distance from the discovery well.

A similar map (not shown) was prepared to show the carbon monoxide concentration in the same area shown in the single figure of the drawing. Such map is very similar to the hydrogen map, hence showing similar anomalies and revealing the fact that carbon monoxide is a significant gas. Exact superposition of maxima of the significant gases does not occur nor would it be expected but sufficient similarity exists to demonstrate that presence of each of the significant gases bears an important relation to the presence of buried carboniferous deposits.

In utilizing the present method of geochemical exploration I prefer to secure samples of soil in a more or less uniform spacing over the earth's surface in areas where buried deposits of oil and gas are possible. Wherever indications of the existence of hydrogen and/or carbon monoxide concentration are found, the area is explored in greater detail by more closely spaced analyses, so that the quality and distribution of these deposits are determined in a way similar to Fig. 1.

For reconnaissance surveys where time is of the essence, gas or air sampling may be resorted to, instead of making use of soil samples. While admittedly of lower sensitivity and resolving power, this method has been found to yield useful indications of the proximity of the sought deposits. The soil method, of course, is to be preferred since the sample may be subjected to such treatment as found expedient to evolve larger quantities of significant gases than occur naturally.

The method of the present invention may be supplemented by use of other known methods of geophysical exploration; for example, use of the reflection seismograph may well follow this geochemical survey prior to drilling. Further, this geochemical method of exploration may be used to supplant other indications of the possible existence of a buried deposit of oil, gas, or associated minerals, such as a prospect indicated by the reflection seismograph, magnetometer, or even a bore hole which had favorable indications.

Core drilling has furnished an important exploration means, and coring during the drilling of a test well further extends this art. Heretofore, however, cores were used almost exclusively for paleontological and lithological correlation.

Experimentation has been conducted to find whether hydrogen and/or carbon monoxide could be evolved from cores. The discovery that hydrogen can be evolved and measured, and further that the amount of hydrogen correlates with other characteristics such as tectonic structure, character of strata traversed by the bore hole, and particularly to proximity to the deposits sought, opens up an entirely new tool for exploration and well logging uses.

Similarly the presence of carbon monoxide, considered by itself or in combination with the hydrogen data, serves as an indicator which is useful for exploration and well logging.

Cores may be treated and analyzed for the significant gases without destroying their usefulness to the paleontologists and geologists who may take the cores for further examination after the analysis has been performed. Further, for purposes of well logging it may not even be necessary to core; the cuttings themselves being found to retain enough included hydrogen and/or carbon monoxide to be useful in the geochemical method herein described. Thus, the same material in the form of cuttings which at present proves valuable in paleontological study may be further examined chemically by the herein disclosed method.

What is claimed is:

1. The method of exploration for carboniferous deposits which comprises the steps of taking samples of soil at or near the surface, treating said samples to evolve in gaseous form constituents entrained therein in normally non-gaseous form and which are due to leakage from said deposits, subjecting the evolved gases to analysis, and determining the amount and presence of hydrogen as an indication of proximity of the respective samples to the sought deposits.

2. The method of exploration for carboniferous deposits by detecting the leakage products from said deposits comprising the steps of systematically taking samples of soil air at selected points in the area to be investigated, analyzing said air, and determining the amount of hydrogen present in said gas.

3. The method of exploration for buried oil, gas and related deposits comprising taking samples of soil, confining said samples, subjecting the samples to heat while confined at a low pressure to evolve in gaseous form constituents entrained therein in normally non-gaseous form

and which are due to leakage from said deposits, and analyzing said evolved gases for the determination of hydrogen therein as an indication of proximity of the soil samples to the buried deposits.

4. The method of exploration for buried oil, gas and related deposits comprising taking samples of soil, subjecting the samples to moisture, confining the moistened samples at a pressure below atmospheric, applying heat to the confined samples to evolve in gaseous form constituents entrained therein in normally non-gaseous form and which are due to leakage from said deposits, and analyzing said evolved gases for the determination of hydrogen as an indication of proximity of the soil samples to the buried deposits.

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